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VARIABLES RELATED TO PERSISTENCE, TRANSFER AND ATTRITION OF ENGINEERING STUDENTS.

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DESCRIPTORS- *ENGINEERING, *COLLEGE STUDENTS, *PERSISTENCE, *STUDENT CHARACTERISTICS, *EDUCATIONAL STATUS COMPARISON, DROPOUT CHARACTERISTICS, TRANSFER STUDENTS, PERFORMANCE FACTORS, MALES, TEST RESULTS, GRADES (SCHOLASTIC), DROPOUTS, STUDENT ATTITUDES, DROPOUT ATTITUDES, UNIVERSITY OF NORTH DAKOTA,

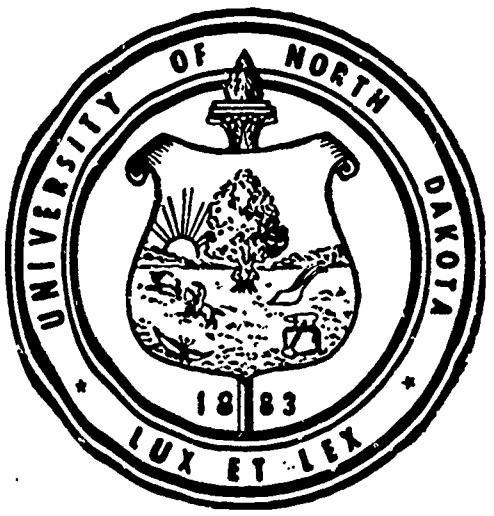
THE SIGNIFICANCE OF THE ACADEMIC AND NONACADEMIC VARIABLES RELATED TO THE PERSISTENCE, TRANSFER, AND ATTRITION OF ENGINEERING STUDENTS WAS STUDIED TO PROVIDE COUNSELORS AND COLLEGES OF ENGINEERING WITH INFORMATION NEEDED TO ASSIST COLLEGE-BOUND YOUTH IN MOVING TOWARD EVENTUAL CAREER SATISFACTION. INFORMATION ON ACADEMIC VARIABLES WAS GATHERED FROM STUDENT RECORDS IN UNIVERSITY OFFICES, AND SCORES FROM THE AMERICAN COLLEGE TEST (ACT) AND NONACADEMIC INFORMATION WAS GATHERED FROM COLLEGE RECORDS AND FROM QUESTIONNAIRES RETURNED BY 316 OF THE 430 MALES ENROLLED IN THE COLLEGE OF ENGINEERING AT THE UNIVERSITY OF NORTH DAKOTA. FINDINGS REVEALED THAT FRESHMAN PERSISTERS HAD SIGNIFICANTLY HIGHER MEAN ACT COMPOSITE SCORES, HIGH SCHOOL GRADES, FIRST SEMESTER COLLEGE GRADES, AND FIRST COLLEGE CHEMISTRY COURSE GRADES THAN FRESHMAN TRANSFERS AND DROPOUTS. THEY ALSO HAD SIGNIFICANTLY HIGHER MEAN ACT MATHEMATICS SUBSCORES AND FIRST COLLEGE ALGEBRA COURSE GRADES THAN FRESHMAN DROPOUTS. THE SOPHOMORE PERSISTERS HAD SIGNIFICANTLY HIGHER MEAN ACT SOCIAL STUDIES SUBSCORES, HIGH SCHOOL GRADES, FIRST SEMESTER COLLEGE GRADES, AND CUMULATIVE COLLEGE-GRADE AVERAGES THAN SOPHOMORE DROPOUTS. THE ACT MATHEMATICS SUBSCORES WERE SIGNIFICANTLY HIGHER FOR JUNIOR PERSISTERS THAN TRANSFERS, AND THEIR HIGH SCHOOL GRADES AND CUMULATIVE COLLEGE GRADES WERE SIGNIFICANTLY HIGHER THAN THOSE OF JUNIOR DROPOUTS. THE SIZE OF THE HIGH SCHOOL GRADUATING CLASS AND THE STUDENTS' EVALUATION OF THE QUALITY OF EDUCATION RECEIVED IN HIGH SCHOOL DID NOT DIFFER SIGNIFICANTLY FOR PERSISTERS, TRANSFERS, AND DROPOUTS. ENGINEERING STUDENTS WITH LESS THAN A STANDARD ACT SCORE OF 26 IN MATHEMATICS, 2.80 HIGH SCHOOL GRADE AVERAGE, 2.05 FIRST SEMESTER COLLEGE GRADE AVERAGE, 2.00 FIRST COLLEGE CHEMISTRY AND MATHEMATICS COURSE GRADES WERE INCLINED TO HAVE PROBLEMS, TO TRANSFER, OR TO DROP OUT OF ENGINEERING. (HC)

Variables Related to Persistence, Transfer And Attrition of Engineering Students

Zeno M. Van Erdewyk

Research Report No. 9

CENTER FOR RESEARCH IN
VOCATIONAL AND TECHNICAL EDUCATION



College of Education
University of North Dakota
Grand Forks

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FOREWORD

One of the main objectives of the Center for Research in Vocational and Technical Education is to promote and stimulate research related to occupational education. The research herein reported, conducted by Dr. Zeno M. Van Erdewyk, was partially supported by the Center. The support of the research projects, such as the one reported here, contributes directly to our purposes.

An additional objective of the Center for Research in Vocational and Technical Education is that of disseminating the results of research studies. The publication of this research report provides an opportunity to fulfill the objective of dissemination.

The information obtained and the insight provided by Dr. Van Erdewyk will have much practical value to persons responsible for guiding the pre-college training of pupils. In addition, those persons involved in directing the programs of college students will find much help in understanding the variables that are related to persistence, transferring and attrition.

Dr. Norman D. Ehresman
Director

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INTRODUCTION

The percentage of entering freshmen who earn an engineer degree has decreased considerably since 1950. The American Society for Engineering Education (1965), with the aid of a National Science Foundation grant, established a committee at the University of Alabama to investigate engineer enrollments; the resultant data were obtained from a questionnaire designed by the committee to obtain information from the deans of accredited engineering schools in the United States. The committee reported that 62.9 per cent of engineering students who had entered as freshmen received a degree in engineering in 1950; the rate was reduced to 48.7 per cent in fifteen engineering schools in 1959. Of the accredited engineering schools participating in the survey, fourteen responded to the question concerning students who transferred out of the engineering program and graduated with some other major. The results clearly indicate that the percentage of freshman engineers who transfer and earn a degree has been on the increase from 1950 to 1959. In 1950, approximately 15 per cent of the students who transferred would earn degrees, while in 1959 this number had increased to about 23 per cent. The committee concluded that most engineering schools do not have the available facts to understand their attrition problems.

Bronwell (1965), dean of engineering at the University of Connecticut, stated that only 40 to 45 per cent of engineering freshmen would receive their degrees in engineering. If effective means could be found for placing the attrition problem in a more understandable perspective, the graduation rate could be increased by at least 50 per cent. Bronwell concluded that then the number of engineers would

be sufficient to meet the projected manpower needs. Another author, David (1962), writing about the increasing shortage of engineers and scientists, reported that about one-half of each engineering class fails to complete the program. Some of the students fail academically, others drop out, and growing numbers of students transfer out of the program.

Reports from the National Science Foundation (1961) and the Engineering Manpower Commission (1962) estimated the national demand for engineers at between 48,000 and 72,000 graduates annually. Dunham (1966) stated that the total number of engineering degrees awarded between 1957 and 1962 averaged only about 32,000. He also reported that the percentage of engineering students within colleges and universities has been decreasing during the past few years. The undergraduate enrollment in engineering dropped to 9.5 per cent of the nation's total college male enrollment in 1965. This figure is down from the 1957 data which showed 14.6 per cent of the college male population enrolled in engineering. The 1965 statistics on the same subject, as reported by Dunham, gave the lowest total in eight consecutive years. Different statistics are reported by Robinson and Lerbinger (1963), but the results indicate a trend in the same direction: They studied the problem of engineer attrition in enrollment and concluded that in 1957, 10.8 per cent of the total freshman enrollments were in the field of engineering; by 1961, the percentage of college freshmen enrolled in engineering had dropped to 6.6 per cent.

Attrition of engineering students is a long term trend as indicated by an earlier study completed by Johnson (1954). Working under the auspices of the Educational Testing Service, Johnson studied 13,000 non-veteran entrants in 101 engineering colleges. Thirty-

three per cent of the entrants had graduated in four years or had completed four years of a five-year program in their institution of initial enrollment. An additional 11 per cent, still enrolled and expecting to graduate, would increase the total graduating percentage to 44. Johnson reported that one-quarter of the students who withdrew from engineering were dropped for academic reasons, and an almost equal proportion withdrew with failing grades; most of the remainder withdrew in good academic standing.

In discussing the figures from the 1960 Department of Labor Bulletin, C. Gilbert Wrenn (1962) stated that professional and technical workers would increase by 41 per cent while skilled workers would increase by 24 per cent during the ten year period of 1960-70.

Supporting Wrenn's discussion, Taylor (1963) envisaged as probable the following changes in employment patterns: (1) the workers most in demand in the years ahead will be those with a marketable skill as evidenced by specialized training; (2) the growth rate in the following named groups will exceed that of total employment: professional-technical, clerical, sales and service workers; (3) the rate of employment growth in the manager-proprietor, craftsman, foreman, and kindred worker groups will be approximately equal to that of total employment; (4) fields with a slower than average growth rate will include operatives and industrial laborers; (5) demand for farm workers will decline significantly.

The preceding discussion on enrollments and attrition in the field of engineering has been limited to an analysis and projection of future manpower needs and the predicted shortage of technically trained personnel. In general, the researchers have concluded that if the proportion of engineer freshmen does not increase, if retention rates

continue to decrease, and if transfers into engineering school do not rise, the technical positions will have to be filled by individuals who lack the technical training demanded for full professional status. The lack of insight in understanding persistence, transferring, and dropping out of an engineering program point up the need for additional research in the area of engineering education. At present, little information is available to the counselor on the relation of academic and non-academic variables to the persistence and attrition of engineering students. The objective of this study is to provide information helpful in identifying some of the factors related to the crucial tasks involved in vocational decision-making and development.

Statement of Problem

This study was designed to answer the following questions:

1. Are there reliable differences in the ACT sub-scores and composite scores when comparisons are made between persisters, transfers, and dropouts?

2. Are there reliable differences in the high school grade point averages when comparisons are made between persisters, transfers, and dropouts?

3. Are there reliable differences in the accumulated college grade point average when comparisons are made between persisters, transfers, and dropouts?

4. Is there a significant relation between the first mathematics course taken, the grades received in college freshman mathematics and chemistry and the attrition of engineering students?

5. Do students who have persisted in engineering, transferred from engineering to another academic major, or dropped out of engineering and college differ on:

   a. biographical variables
   b. their evaluation of their high school preparation
   c. responses to questions relating to their decision to enter engineering

d. their experiences in the college of engineering
e. other non-academic variables included in the questionnaire?

Definition of Terms

1. Academic variables -- For the purpose of this study, academic variables are defined as scores obtained on the ACT test; high school grade point average; college grade point average; first college mathematics course taken; and grades obtained in freshman mathematics and chemistry.
2. Non-academic variables -- Non-academic variables consist of data as obtained from questionnaires.
3. Persisters -- Persisters are those students who were enrolled in the college of engineering during the 1966-67 academic year.
4. Transfers -- Transfers are those students who left engineering during or at the end of the 1965-66 academic year and changed to another curriculum on campus for the 1966-67 academic year.
5. Dropouts -- Dropouts are those students who discontinued their association with the college of engineering during or at the end of the 1965-66 academic year and left the university altogether.

Description of the Variables Employed

The academic variables employed in this research included the ACT sub-scores and composite score; high school GPA; first semester cumulative GPA for freshmen, first and third semester cumulative GPA for sophomores, and first, third, and fifth semester cumulative GPA for juniors. The grades received during the first semester of college chemistry and mathematics and the particular mathematics course taken are also considered academic variables.

Information about the academic variables was gathered from student records in the Registrar's office, Counseling Center, College of Engineering, and the Office of the Dean of Students.

The non-academic variables employed in this research included all of the items on the questionnaire and additional items obtained from the student's records.

The non-academic variables employed in this research, primarily, consisted of the items found on the questionnaires. Copies of questionnaires sent to persisters, transfers, and dropouts are found in Academic and Non-Academic Variables Related to Persistence, Transfer, and Attrition of Engineering Students, Zeno Van Erdewyk, June 1967.

Statistical Treatment of Data

The first four hypotheses were tested by use of the one-way analysis of variance program. For these hypotheses, means and sums of squares were computed for each of the variables involved. *F* tests were computed for each variable and the *t* ratio was used to test for

group differences where the *F* test was significant. The .05 level of significance was used in evaluating the *F* ratios. In apply a number of *t* tests following an *F* test, Ferguson (1959) indicates that a more rigorous basis than usual is required for rejecting the null hypothesis. He suggests that instead of using the 5 per cent level of rejection the 10/k (k-1) per cent level be used, where k is the number of groups. For comparing three groups, the critical level of rejection becomes the 1.667 per cent level. Since no hypothesized direction of relationship was formulated, a two-tailed test was used in all instances. The data on two items from the questionnaires were judged to be appropriate for the analysis of variance statistic. These items were (1) grade the student decided to enter college and (2) grade the student decided to enter engineering. The responses by the students to the remaining items on the questionnaire were judged to be appropriate for non-parametric statisical analyses or for tabulation of frequencies.

RESEARCH DESIGN

The population of this study consisted of 430 males enrolled as freshmen, sophomores, and juniors in the College of Engineering at the University of North Dakota during the 1965-66 academic school year. Students were classified as persisters, transfers, or dropouts, at each class level, contingent upon their status for the 1966-67 academic year. The distribution of the student population is presented in Table 1.

TABLE 1

DISTRIBUTION OF ENGINEERING STUDENTS BY CLASS: PERSISTERS, TRANSFERS, AND DROPOUTS

	Persisters		Transfers		Dropouts		Total	
Class	N	%	N	%	N	%	N	%
Freshmen	143	71	23	11	36	18	202	100
Sophomores	81	61	18	13	34	26	133	100
Juniors	75	79	5	5	15	16	95	100

N = 430

The number of questionnaires sent out to the persisters, transfers, and dropouts was 430 and the number returned was 316. The transfer groups had the highest percentage of return (78 per cent) and the dropouts had the lowest (65 per cent). The total percentage of returns for the three groups was 73 per cent.

RESULTS

The findings of this study are presented in the order of the five questions proposed earlier in this report. The questions were recast in the form of null hypotheses for statistical testing. The data used to test each stated null hypothesis are followed by a summary statement of the results.

TABLE 2

MEAN SCORES ON ACT SUB-TESTS AND COMPOSITE SCORE FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

Group	N	English	Math	Social Studies	Natural Science	Composite
Freshmen	176					
Persisters	122	20.47	27.87	25.04	26.03	24.96
Transfers	21	19.05	26.05	23.00	24.33	23.24
Dropouts	33	19.06	25.27	23.33	24.03	23.09
Sophomores	111					
Persisters	63	20.41	27.38	24.67	26.03	24.71
Transfers	17	21.41	26.53	25.65	26.94	25.18
Dropouts	31	19.32	25.16	22.45	24.68	23.13
Juniors	67					
Persisters	55	20.78	27.62	24.25	25.80	24.82
Transfers	3	19.00	20.33	18.67	20.33	20.00
Dropouts	9	21.44	25.56	24.33	25.56	24.22

N = 354

Hypothesis 1. There are no reliable differences in the ACT sub-scores and composite score when comparisons are made between persisters, transfers, and dropouts. Table 2 presents the mean scores on the ACT sub-tests and composite score for persisters, transfers, and dropouts at each class level.

Fifteen analyses of variance were computed to test the null hypothesis that there were no significant differences. Significant differences between persisters, transfers, and dropouts were found for the following

TABLE 3

SIGNIFICANT DIFFERENCES BETWEEN MEANS ON ACT SUB-TESTS AND COMPOSITE SCORE FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

Group	Lower Mean	Higher Mean	*t* ratio
Freshmen			
ACT Mathematics	Dropouts	Persisters	9.80**
ACT Composite	Transfers	Persisters	3.94**
	Dropouts	Persisters	6.80**
Sophomores			
ACT Social Studies	Dropouts	Persisters	4.64**
	Dropouts	Transfers	5.10**
Juniors			
ACT Mathematics	Transfers	Persisters	7.64**
	Transfers	Dropouts	3.11*

Significance level established at .0167 *p<.01 **p<.001

four variables: (1) ACT-mathematics for freshmen; (2) ACT-composite for freshmen; (3) ACT-social studies for sophomores; and (4) ACT-mathematics for juniors. The significant differences which were determined by *t* tests are presented in Table 3.

Freshman dropouts scored significantly lower on the ACT mathematics sub-test than did the freshman persisters. Freshman transfers and dropouts scored significantly lower on the ACT composite score than the freshman persisters. Sophomore dropouts scored significantly lower on the ACT social studies sub-test than the persisters and transfers. Junior transfers scored significantly lower on the ACT mathematics sub-test than the persisters and dropouts.

TABLE 4

MEAN HIGH SCHOOL GRADE POINT AVERAGE FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

Group	N	High School Grade Point Average
Freshmen	167	
Persisters	118	3.12
Transfers	19	2.68
Dropouts	30	2.51
Sophomores	107	
Persisters	63	3.23
Transfers	17	3.21
Dropouts	27	2.57
Juniors	54	
Persisters	45	3.19
Transfers	2	3.13
Dropouts	7	2.54

N = 328

Hypothesis 2. There are no reliable differences in the high school grade point average when comparisons are made between persisters, transfers, and dropouts. Table 4 presents the mean scores on the high school grade point average for persisters, transfers, and dropouts at each class level.

Three analyses of variance were computed to test the null hypothesis. Significant differences were found between persisters, transfers, and dropouts at each class level. Significant group differences are presented in Table 5.

TABLE 5

SIGNIFICANT DIFFERENCES BETWEEN HIGH SCHOOL GRADE POINT AVERAGES FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

Group	Lower Mean	Higher Mean	t ratio
Freshmen			
	Transfers	Persisters	7.64**
	Dropouts	Persisters	20.67**
Sophomores			
	Dropouts	Persisters	25.65**
	Dropouts	Transfers	13.23**
Juniors			
	Dropouts	Persisters	7.42**

Significance level established at .0167 **p<.001

Freshman transfers and dropouts had significantly lower high school grade point averages than the persisters. Sophomore dropouts had significantly lower high school grade point averages than the persisters and transfers. Junior dropouts had significantly lower high school grade point averages than the junior persisters.

Hypothesis 3. There are no reliable differences in the accumulated college grade point average when comparisons are made between persisters,

transfers, and dropouts. Analyses were computed for first semester grade point average for persisters, transfers, and dropouts at each class level; third semester cumulative grade point averages for persisters, transfers, and dropouts in the sophomore and junior classes; and fifth semester cumulative grade point average for persisters, transfers, and

TABLE 6

MEAN CUMULATIVE GRADE POINT AVERAGES AT THE END OF THE FIRST, THIRD, AND FIFTH SEMESTERS FOR PERSISTERS, TRANSFERS, AND DROPOUTS

Group	N	1st Sem GPA	3rd Sem GPA	5th Sem GPA
Freshmen	202			
Persisters	143	2.41		
Transfers	23	2.15		
Dropouts	36	1.81		
Sophomores	133			
Persisters	81	2.56	2.50	
Transfers	18	2.45	2.39	
Dropouts	34	2.24	1.95	
Juniors	95			
Persisters	75	2.56	2.56	2.52
Transfers	5	2.40	2.27	2.19
Dropouts	15	2.23	2.16	1.90

dropouts in the junior class. The mean cumulative grade point averages for the three groups are presented in Table 6.

Significant *F* ratios were found when cumulative GPA's were compared at the end of the first semester for freshmen and sophomores; at the end of the third semester for sophomores and juniors; and at the end of the

fifth semester for juniors. Results of subsequent *t* tests indicating significant group differences are presented in Table 7.

TABLE 7

SIGNIFICANT DIFFERENCES BETWEEN FIRST, THIRD, AND FIFTH SEMESTER CUMULATIVE GRADE POINT AVERAGES FOR PERSISTERS, TRANSFERS, AND DROPOUTS

Group	Lower Mean GPA	Higher Mean GPA	*t* ratio
Freshman-1st Sem.			
	Transfers	Persisters	2.83*
	Dropouts	Persisters	21.18**
	Dropouts	Transfers	3.13*
Sophomore-1st Sem.			
	Dropouts	Persisters	7.29**
Sophomore-3rd Sem.			
	Dropouts	Persisters	23.31**
	Dropouts	Transfers	7.76**
Junior-3rd Sem.			
	Dropouts	Persisters	8.89**
Junior-5th Sem.			
	Dropouts	Persisters	15.36**

Significance level established at .0167 *p<.01 **p<.001

Freshman transfers and dropouts had significantly lower grade point averages at the end of the first semester than persisters. Freshman dropouts had significantly lower mean grade point averages at the end of the first semester than the transfers. The mean grade point average earned by sophomore dropouts during their first semester was significantly

lower than that earned by persisters. Sophomore dropouts had significantly lower cumulative grade point averages at the end of the third semester than the persisters and transfers. The cumulative grade point average for junior dropouts at the end of their third semester was

TABLE 8

MEAN GRADE IN FIRST COLLEGE CHEMISTRY COURSE AND FIRST MATHEMATICS COURSE: COLLEGE ALGEBRA, TRIGONOMETRY, AND ANALYTIC GEOMETRY AND CALCULUS FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

Group	Chemistry		Algebra		Trigonometry		Analytic Geometry and Calculus	
	N		N		N		N	
Freshmen	202		118		26		58	
Persisters	143	2.14	74	2.64	22	2.55	47	2.44
Transfers	23	1.74	17	2.29	3	1.67	3	3.33
Dropouts	36	1.47	27	1.93	1	2.00	8	2.25
Sophomores	133		70		34		28	
Persisters	81	2.57	32	3.00	25	2.72	24	2.70
Transfers	18	2.11	12	2.42	2	3.50	4	2.00
Dropouts	34	2.00	26	2.38	7	3.00	1	2.00
Juniors	95		41		46		8	
Persisters	75	2.41	29	2.55	40	2.57	6	1.83
Transfers	5	2.20	3	2.00	1	3.00	1	2.00
Dropouts	15	2.27	9	2.11	5	2.80	1	2.00

significantly lower than that for the persisters. Junior dropouts had significantly lower cumulative grade point averages at the end of the fifth semester than the persisters.

Hypothesis 4. There is no significant relation between the first mathematics course taken, the grades received in college freshmen mathe-

matics and chemistry and the attrition of engineering students. The analyses on the mathematics course were dependent upon whether the student enrolled in College Algebra, Trigonometry, or Analytic Geometry and Calculus as his first mathematics course. Table 8 presents the mean grade in the first course in chemistry and mathematics for persisters, transfers, and dropouts at each class level.

Because of insufficient data four of the twelve planned analyses of variance could not be computed. Eight analyses of variance were computed to test the null hypothesis that there were no significant differences. Significant F ratios were found for the following four variables: (1) the grade received in the first semester of college chemistry for freshmen; (2) the grade received in the first semester of College Algebra for freshmen; (3) the grade received in the first semester of college chemistry for sophomores; and (4) the grade received in the first semester of College Algebra for sophomores. Subsequent t tests indicated the significant group differences presented in Table 9. Freshman transfers and dropouts had significantly lower mean grades in chemistry than the persisters. The mean grade in algebra for freshman dropouts was significantly lower than the persisters. Sophomore transfers and dropouts had significantly lower mean grades in chemistry and significantly lower mean grades in algebra than the persisters.

A chi square test was used to determine if a relationship existed between the first mathematics course taken, College Algebra, Trigonometry, or Analytic Geometry and Calculus, and whether the students persisted, transferred, or dropped out; Table 10 presents the results. The data provide evidence that there is a significant relation between the first mathematics course taken and the attrition of engineering students. It is of

interest that a large proportion of transfers and dropouts, 72 per cent and 76 per cent respectively, took College Algebra as their first course in mathematics as compared to 47 per cent of the persisters.

TABLE 9

SIGNIFICANT DIFFERENCES BETWEEN MEANS ON THE GRADE IN FIRST COLLEGE CHEMISTRY COURSE AND FIRST MATHEMATICS COURSE: COLLEGE ALGEBRA, TRIGONOMETRY, AND ANALYTIC GEOMETRY AND CALCULUS FOR PERSISTERS, TRANSFERS, AND DROPOUTS

Group	Lower Mean Grade	Higher Mean Grade	*t* ratio
Freshman-Chemistry			
	Transfers	Persisters	8.63**
	Dropouts	Persisters	24.56**
Freshman-Algebra			
	Dropouts	Persisters	14.40**
Sophomore-Chemistry			
	Transfers	Persisters	4.33**
	Dropouts	Persisters	10.83**
Sophomore-Algebra			
	Transfers	Persisters	4.60**
	Dropouts	Persisters	8.53**

Significance level established at .0167 **p<.001

Hypothesis 5. Students who have persisted in engineering, transferred from engineering to another academic major, or dropped out of engineering

and college do not differ on:

a. biographical variables
b. their evaluation of their high school preparation
c. responses to questions relating to their decision to enter engineering
d. their experiences in the college of engineering
e. other variables included in the questionnaire.

TABLE 10

FIRST MATHEMATICS COURSE FOR PERSISTERS, TRANSFERS, AND DROPOUTS: OBSERVED FREQUENCIES FOR A CHI SQUARE TEST

Math Course	Persisters		Transfers		Dropouts	
	N	%	N	%	N	%
College Algebra	140	47	33	72	65	76
Trigonometry	87	29	6	13	12	14
Analytic Geometry and Calculus	72	24	7	15	8	10

χ^2=29.18; p<.001, χ^2=18.46, df=4

This hypothesis is composed of items taken from the questionnaires found in Academic and Non-Academic Variables Related to Persistence, Transfer, and Attrition of Engineering Students, Zeno Van Erdewyk, June 1967. The responses by the students to the items on the questionnaire were judged to be appropriate for parametric or non-parametric statistical analysis or for tabulation of frequencies.

Item 1. "How many students were in your high school graduating class?" Table 11 presents the results of a chi square test on the size of the high school graduating class. The chi square value of 2.43 was not

significant. Therefore, the data do not provide evidence that the size of the high school graduating class is related to student attrition.

TABLE 11

SIZE OF HIGH SCHOOL GRADUATING CLASS FOR PERSISTERS, TRANSFERS, AND DROPOUTS: OBSERVED FREQUENCIES FOR A CHI SQUARE TEST

Size of high school graduating class	Persisters		Transfers		Dropouts	
	N	%	N	%	N	%
1-25	65	22	8	18	15	18
26-75	107	37	21	47	35	41
76-151+	121	41	16	35	35	41

$\chi^2=2.43$; $p<.05$, $\chi^2=9.49$, df=4

Item 2. "How well did the courses you completed in high school prepare you for work in engineering at UND?" Table 12 presents the results of a chi square test on the student's evaluation of their high school preparation. The chi square value of 3.63 was not significant. Thus, the data do not provide evidence that the student's evaluation of the high school preparation is related to his persistence in engineering. It should be noted that a large proportion of transfers, 70 per cent, viewed their high school preparation as "excellent-or-good" as compared to 57 per cent and 55 per cent of the persisters and dropouts respectively.

Item 3. "What could your high school have done to better prepare you for engineering at UND?" Analysis on this item indicated that a majority of the students felt a definite need for their high schools to provide them with "more information on engineering." Another observation was that a higher proportion of persisters and dropouts, than transfers felt a need for "more mathematics."

TABLE 12

EVALUATION OF HIGH SCHOOL PREPARATION BY PERSISTERS, TRANSFERS, AND DROPOUTS: OBSERVED FREQUENCIES FOR A CHI SQUARE TEST

High School Evaluation	Persisters N	Persisters %	Transfers N	Transfers %	Dropouts N	Dropouts %
Excellent-or-good	128	57	25	70	30	55
Fair	72	32	7	19	15	28
Poor-or-questionable	26	11	4	11	9	17

$\chi^2=3.63$; $p<.05$, $\chi^2=9.49$, df=4

Item 4. "What one course in engineering did you find most interesting?" The highest proportion of freshman and sophomore persisters, transfers, and dropouts indicated engineering graphics as the most interesting course. The junior persisters indicated mathematics as the most interesting course in engineering, but the dropouts indicated engineering graphics as the most interesting.

Item 5. "What one course in engineering did you find least interesting?" The highest proportion of freshman persisters and dropouts reported English as the least interesting course; the transfers indicated chemistry as least interesting. With the sophomore group, the highest proportion of persisters and dropouts indicated English as the least interesting; the transfers cited chemistry. The junior persisters and dropouts indicated English as being the least interesting; a higher proportion of the transfers reported mathematics as least interesting in the engineering program.

Item 6. "In your opinion, is there a need for a one or two year program in engineering to prepare an individual to become an engineering technician or engineering assistant?" Table 13 presents the frequency of each response. As indicated in the table, the majority of students saw a definite need for a one or two year program in engineering. A comparatively high proportion of the total group stated, "I really do not know." At each higher class level a larger percentage of the transfers and dropouts and a smaller percentage of the persisters indicated a need for a one or two year program in engineering.

Item 7. "If a one or two year program designed to prepare an individual to become an engineering technician or assistant had been offered when you entered UND, would you have been interested in enrolling in such a program?" Table 14 presents the frequency of each response for persisters, transfers, and dropouts at each class level. As indicated in the table, at each class level, a higher proportion of transfers and dropouts, than of persisters, stated that they would have considered enrolling in a one or two year engineering program at UND. About 50 per cent of the transfers and dropouts indicated that they would have been interested in enrolling

TABLE 13

RESPONSES TO QUESTION: "IN YOUR OPINION, IS THERE A NEED FOR A ONE OR TWO YEAR PROGRAM IN ENGINEERING TO PREPARE AN INDIVIDUAL TO BECOME AN ENGINEERING TECHNICIAN OR ENGINEERING ASSISTANT?" FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

Response	Freshmen						Sophomores						Juniors					
	P		T		DO		P		T		DO		P		T		DO	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Yes	51	51	9	53	13	65	36	55	9	60	16	70	30	50	3	75	7	78
No	8	8	1	6	1	5	5	8	1	7	1	4	9	15	0	0	1	11
I really do not know	41	41	7	41	6	30	24	37	5	33	6	26	21	35	1	25	1	11

TABLE 14

RESPONSES TO QUESTION: "IF A ONE OR TWO YEAR PROGRAM DESIGNED TO PREPARE AN INDIVIDUAL TO BECOME AN ENGINEERING TECHNICIAN OR ASSISTANT HAD BEEN OFFERED WHEN YOU ENTERED UND, WOULD YOU HAVE BEEN INTERESTED IN ENROLLING IN SUCH A PROGRAM?" FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

	Freshmen						Sophomores						Juniors					
	P		T		DO		P		T		DO		P		T		DO	
Response	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Yes	34	34	10	59	13	62	13	20	7	50	12	50	9	15	2	50	4	44
No	45	45	4	23	5	24	37	57	5	36	10	42	45	75	2	50	5	56
I really do not know	21	21	3	18	3	14	15	23	2	14	2	8	6	10	0	0	0	0

in a one or two year engineering program. At each higher class level fewer persisters indicated their interest in such programs.

Item 8. "Could the College of Engineering take steps to better serve the students enrolled in engineering?" Table 15 presents the students' responses to this question. A higher proportion of persisters, 87 per cent, as compared to the transfers (67 per cent) and dropouts (74 per cent) indicated that the College of Engineering could take steps to better serve the students enrolled in engineering.

TABLE 15

RESPONSES TO QUESTION: "COULD THE COLLEGE OF ENGINEERING TAKE STEPS TO BETTER SERVE THE STUDENTS ENROLLED IN ENGINEERING?" FOR PERSISTERS, TRANSFERS, AND DROPOUTS

Response	Persisters		Transfers		Dropouts	
	N	%	N	%	N	%
Yes	191	87	22	67	35	74
No	29	13	11	33	12	26

Analysis on the comments of this item indicated that the engineering department could better serve students by taking the following three steps: (1) improving quality of instruction; (2) providing better faculty counseling; and (3) conducting a seminar-type of course on the "Nature of Engineering."

Item 9. "Students give many reasons for deciding to major in engineering. What influenced your decision to enter engineering?" The results of this item indicated that the highest proportion of the responses given by persisters, at each class level, was "interest in mathematics and science"

and "interest in mechanical things." Similarly, the sophomore dropouts reported the highest proportion of responses as: "interest in mathematics and science" and "interest in mechanical things." The freshman transfers and dropouts indicated the highest proportion of responses as: "interest in mathematics and science" and "interest in type of work." The sophomore transfers cited "interest in mathematics and science" and "money." The junior dropouts indicated "interest in mathematics and science" and "challenge" as the highest proportion of responses. The highest proportion of responses made by the junior transfer group for their decision to enter engineering was "interest in mathematics and science."

Item 10. "What individual was the most influential in your decision to enter engineering?" Table 16 presents the frequencies and percentages of responses made by persisters, transfers, and dropouts at each class level. The highest proportion of freshman persisters, transfers, and dropouts, 26 per cent, 24 per cent, and 45 per cent respectively, indicated that it was their own decision to enter engineering. The highest proportion of sophomore and junior dropouts, 29 per cent, reported that it was their own decision to enter engineering. The highest proportion of responses made by sophomore persisters and transfers and the junior transfers, 25 per cent, 33 per cent, and 50 per cent respectively, indicated that their parents were the most influential individuals in their decision to enter engineering.

Item 11. "How certain was your decision to major in engineering when you entered UND?" Table 17 presents the results of a chi square test on the certainty of choice in engineering for persisters, transfers, and dropouts. The chi square value 18.06 was significant at the .001 level.

TABLE 16

RESPONSES TO QUESTION: "WHAT INDIVIDUAL WAS THE MOST INFLUENTIAL IN YOUR DECISION TO ENTER ENGINEERING?" FOR PERSISTERS, TRANSFERS, AND DROPOUTS AT EACH CLASS LEVEL

Response	Freshmen						Sophomores						Juniors					
	P		T		DO		P		T		DO		P		T		DO	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Parents	21	21	3	17	2	10	16	25	5	33	4	17	9	15	2	50	2	22
High school teacher	10	12	2	12	2	10	12	19	1	7	3	13	9	15	1	25	0	
High school counselor	11	11	3	17	1	5	4	6	1	7	1	4	3	5	0		1	11
Relative	15	15	1	6	0		7	11	4	26	2	8	4	7	0		0	
Friend	9	9	2	12	4	20	7	11	1	7	5	21	8	14	0		1	11
My own decision	25	26	4	24	9	45	12	19	1	7	7	29	17	29	1	25	5	56
Other	8	8	2	12	2	10	6	9	2	13	2	8	9	15	0		0	

Therefore, the data suggest that uncertainty of vocational choice is related to transferring from the engineering program. A higher proportion of persisters and dropouts, 87 per cent and 83 per cent respectively, indicated a higher degree of certainty than the transfer groups (58 per cent).

TABLE 17

CERTAINTY OF ENGINEERING CHOICE FOR PERSISTERS, TRANSFERS, AND DROPOUTS: OBSERVED FREQUENCIES FOR A CHI SQUARE TEST

Certainty of choice	Persisters N	Persisters %	Transfers N	Transfers %	Dropouts N	Dropouts %
Very or fairly certain	194	87	21	58	44	83
Somewhat or very doubtful	29	13	15	42	9	17

χ^2=18.06; p<.001; χ^2=13.82, df=2

Item 12. "If your plans for the future require additional education, what kind of education are you interested in receiving and where will you obtain the education?" The analysis on this item applied only to the students who dropped out of engineering and the University of North Dakota. Table 18 presents the frequency of responses made by the dropouts at each class level. It is apparent from the table that the highest proportion of sophomore and junior dropouts, 50 per cent and 72 per cent respectively, reported that they wanted additional education in engineering; however, the highest proportion of freshman dropouts, 40 per cent, indicated interest in receiving education not related to engineering. The majority of freshman, sophomore, and junior dropouts, 60 per cent, 58 per cent, and 86 per cent respectively, indicated plans to receive their additional education at a college or university.

TABLE 18

RESPONSES TO QUESTION: "IF YOUR PLANS FOR THE FUTURE REQUIRE ADDITIONAL EDUCATION, WHAT KIND OF EDUCATION ARE YOU INTERESTED IN RECEIVING AND WHERE WILL YOU OBTAIN THIS EDUCATION?" FOR DROPOUTS AT EACH CLASS LEVEL

Response	Freshmen N	Freshmen %	Sophomores N	Sophomores %	Juniors N	Juniors %
Kind of education						
Engineering	3	30	6	50	5	72
Technical	3	30	5	42	1	14
Non-engineering	4	40	1	8	1	14
Obtained at						
College	6	60	7	58	6	86
Technical school	2	20	5	42	1	14
Military service	2	20				

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to determine if significant differences existed on selected academic and non-academic variables for those students who persist in engineering, those who transfer from engineering to another academic major, and those who drop out of engineering and college. Previous research, using high school and college students as subjects in studies of the relation between academic and non-academic variables and persistence, transferring, and dropping out, suggested that academic and non-academic variables must be given consideration in studying the academic behavior of college students in engine[illegible].

The findings of the investigatio[illegible]s follows:

1. Freshman persisters had significantly higher ACT mathematics sub-scores than the freshman dropouts; freshman persisters had significantly higher ACT composite scores than the transfers and dropouts; sophomore persisters and transfers had significantly higher ACT social studies sub-scores than the sophomore dropouts; and junior persisters and dropouts had significantly higher ACT mathematics sub-scores than junior transfers.

2. Freshman persisters had significantly higher mean high school grades than freshman transfers and dropouts; sophomore persisters and transfers had significantly higher mean high school grades than sophomore dropouts; and junior persisters had significantly higher mean high school grades than junior dropouts.

3. Freshman persisters had significantly higher mean first semester grades than freshman transfers and dropouts; freshman transfers had significantly higher mean first semester grades than did the freshman dropouts; sophomore persisters had significantly higher mean first semester grades than the sophomore dropouts; sophomore persisters and transfers had significantly higher cumulative grade point averages at the end of the third semester than the dropouts; junior persisters had significantly higher

cumulative grade point averages at the end of the third semester than the dropouts; and junior persisters had significantly higher cumulative grade point averages, at the end of the fifth semester, than the junior dropouts.

4. Freshman persisters had a significantly higher mean grade in their first course in college chemistry than freshman transfers and dropouts; freshman persisters had a significantly higher mean grade in their first semester of college algebra than freshman dropouts. Sophomore persisters had a significantly higher grade in their first course in college chemistry than sophomore transfers and dropouts; sophomore persisters had a significantly higher mean grade in their first semester of college algebra than sophomore transfers and dropouts. A significantly higher proportion of transfers and dropouts than the persisters took College Algebra as their first course in mathematics.

5. Some of the principal results of the questionnaire are as follows: The size of the high school graduating class and the students' evaluation of the quality of education they received in high school did not differ significantly for persisters, transfers, and dropouts. A majority of students felt a definite need for their high school to provide them with more information on engineering. A majority of students reported engineering graphics as the most interesting course; English was reported as the least interesting course taken in the engineering program. A majority of students, 56 per cent, indicated the need for a one or two year program in engineering. The most frequently reported suggestions for improving the college of engineering were to improve quality of instruction, better faculty counseling, and a seminar on the nature of engineering. Thirty-four per cent of the students reported an interest in mathematics and science as being the most influential factor in their decision to enter engineering. The highest proportion of the persisters and dropouts, 28 per cent, indicated that it was their decision to enter engineering, 28 per cent of the transfers indicated their parents as being most influential in their decision to enter engineering. Transfer students were less certain about their decision to enter engineering than persisters and dropouts. A majority of the dropouts, not enrolled in school, reported that their future plans required additional education in engineering or technical fields.

Counselors and advisors might consider the following findings helpful in gaining a better understanding of student attrition:

1. A prospective engineering student having less than a standard score of 26 on the ACT mathematics test may encounter difficulties in completing the program.

2. Prospective students having less than a 2.80 high school grade point average, using a four point system, exhibit the tendency to transfer or drop out of the engineering program.

3. Freshman students receiving less than a 2.05 first semester grade point average, using a four point system, are inclined to transfer or drop out of engineering.

4. Freshman students receiving less than a 2.00 in their first course in college chemistry and mathematics, using a four point system, are inclined to transfer or drop out of engineering.

5. A higher proportion of persisters, 24 per cent, compared to the transfers and dropouts, 15 per cent and 10 per cent respectively, take Analytic Geometry and Calculus as their first course in college mathematics.

6. Engineering students expressed concern with the quality of instruction and faculty counseling and suggested an orientation program providing information on the various kinds of engineering and what an engineer does in his particular field.

7. Students indicating that they were somewhat doubtful or uncertain about their vocational choice are inclined to transfer out of an engineering program.

Conclusions

A better understanding of the academic and non-academic variables related to persistence, transferring, and attrition of engineering students will provide counselors and colleges of engineering with information needed to assist college-bound youth in moving toward eventual career satisfaction. The present study reported the significance of academic and non-academic variables in studying the academic behavior of students enrolled in an engineering program. An awareness of these differences will help counselors and other interested personnel to understand the variables that are related to persistence, transferring, and attrition.

Counselors tend to limit their concern with academic potential as the only variable in predicting college success; however, research by Berdie (1951), Cronbach (1949), and Stuit *et al*, (1949) indicates that

about one-tenth to one-half of the variance in academic performance may be attributed to the variance in intellective factors as measured by tests of scholastic aptitude. In discussing non-academic variables, Holland and Richards (1966) reported that educators can not neglect the significance of this variable and its relationship to college success. Therefore, counselors can not neglect the role of non-academic variables in the vocational choice of the individual.

A potential engineering student may be happier and may conceivably experience less academic frustration if he is made aware of his potentials and limitations before he engages in an engineering curriculum. It is desirable that counselors understand which academic and non-academic variables are important to successful completion of an engineering program. The counselor who understands an individual in this frame of reference may be better able to help the client discover his educational objective.